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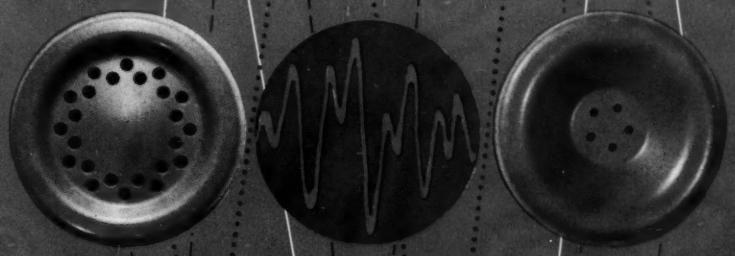
GENERAL TELEPHONE TECHNICAL JOURNAL



VOLUME 6 NUMBER 1

GENERAL SYSTEM

DIAL MOBILE RADIOTELEPHONE SYSTEM

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GENERAL TELEPHONE TECHNICAL JOURNAL

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The first article in this issue is the report of an outstanding development in Communications — a development that greatly lengthens the reach of dial telephony. With the new "Dial Mobile Radio System" which it describes, moving vehicles can call and be called as easily as land telephones. And so efficient and economical is this system that it offers a means, also, of bringing commercial telephone service to land locations that are beyond the economic reach of land lines. Here is a development that will be of interest to every telephone man.

Our second article brings together a description of many developments that have been made through the years, to provide the wide variety of paystation service facilities now available to telephone companies. This article details many of the factors to be considered in choosing paystation service for a given situation; you'll be glad to have it in your file when the problem comes up.

DIAL MOBILE RADI

By R. P. DIMMER,

Senior Project Engineer, General Telephone Laboratories, Inc.

Mobile Radiotelephone Systems have brought the convenience of telephone service to cars, trucks, boats and other vehicles. The systems have proved to be also a practical means of serving many fixed locations in rural areas which are beyond the limits of wire-lines. Since the present systems do not provide selective dial service they require the assistance of an operator to complete connections.

This article describes a new dial selective system for mobile units which will allow the subscriber to dial another subscriber individually without the assistance of the operator. To the mobile subscriber, this operation would be almost the same as making a call through wire-line facilities.

In such wire-line telephone systems, when a call is placed from one subscriber to another, a DC loop circuit is completed between the calling telephone and the central office equipment. This circuit sets up a train of operations within the central office equipment, and an idle incoming selector is seized. As long as the subscriber holds the handset in the off-hook position the DC loop circuit is held; when he dials a number the circuit is advanced through a network of switches and relays to complete the call to the other station.

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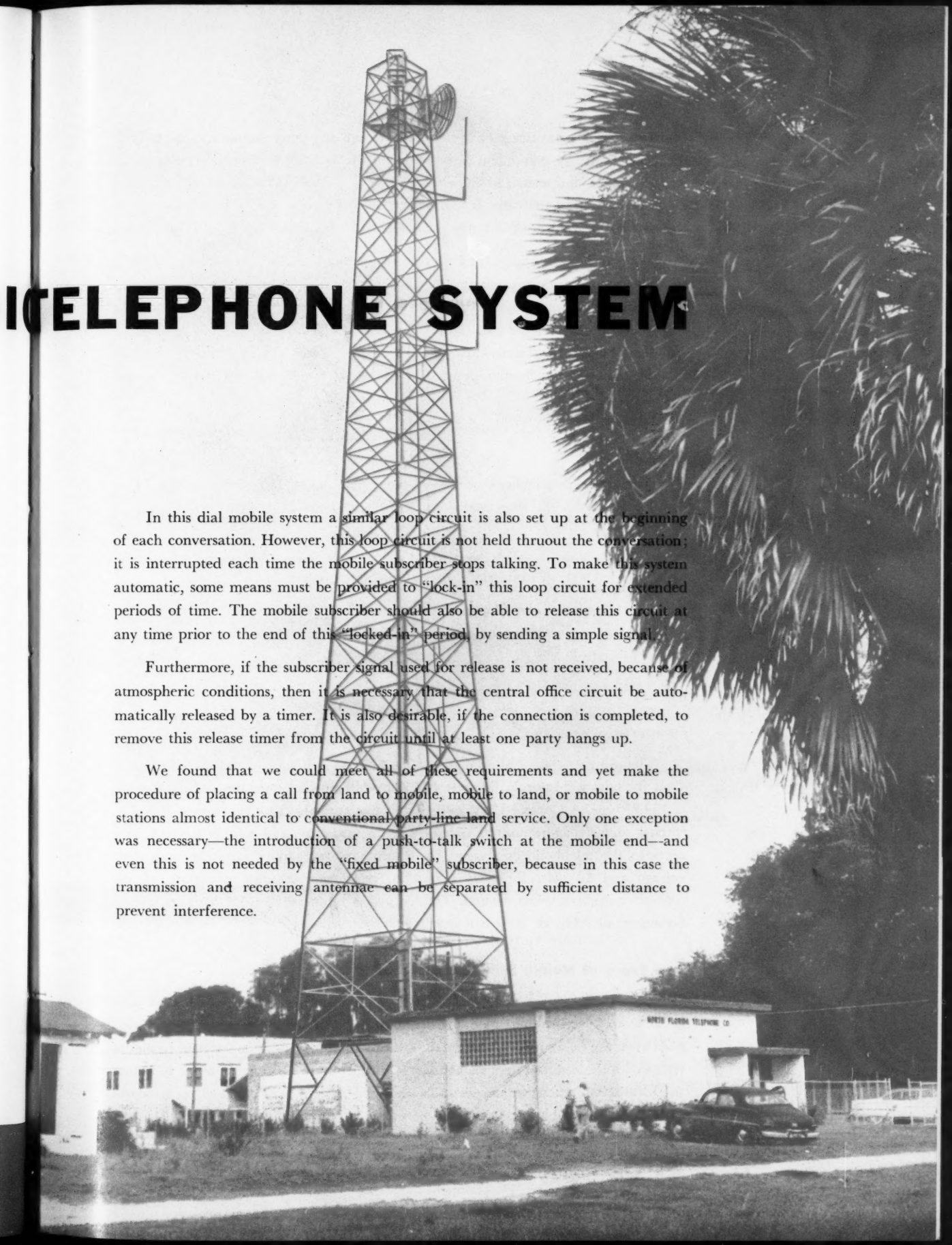


In this dial mobile system a similar loop circuit is also set up at the beginning of each conversation. However, this loop circuit is not held thruout the conversation; it is interrupted each time the mobile subscriber stops talking. To make this system automatic, some means must be provided to "lock-in" this loop circuit for extended periods of time. The mobile subscriber should also be able to release this circuit at any time prior to the end of this "locked-in" period, by sending a simple signal.

Furthermore, if the subscriber signal used for release is not received, because of atmospheric conditions, then it is necessary that the central office circuit be automatically released by a timer. It is also desirable, if the connection is completed, to remove this release timer from the circuit until at least one party hangs up.

We found that we could meet all of these requirements and yet make the procedure of placing a call from land to mobile, mobile to land, or mobile to mobile stations almost identical to conventional party-line land service. Only one exception was necessary—the introduction of a push-to-talk switch at the mobile end—and even this is not needed by the "fixed mobile" subscriber, because in this case the transmission and receiving antennae can be separated by sufficient distance to prevent interference.

The system permits a mobile subscriber to call any other mobile station through the central control equipment without using the existing telephone reverting call technique and equipment. At the present time the system is not designed for Direct Distance Dialing of toll calls. It is expected that when this type of telephone service becomes nationwide, long-distance toll dialing will be incorporated into the system.

To record a time charge for each call, without an operator, it would be necessary to utilize some form of automatic toll ticketing device to time and record all calls; this equipment would be too expensive on a 20-party line. Alternatively, local calls might be charged on a flat-rate basis; one of the purposes of our pilot installation at Branford, Florida, is to study the feasibility of this method. During this trial period, all toll calls will go through a regular toll operator, and will be charged at the usual rate.

It is anticipated that this new mobile system will eventually serve in the following ways:

a) Provide telephone service to isolated ranches, farm houses, and islands in areas not served by telephone wire-lines. This might be called "Fixed Mobile" Service.

b) Provide mobile subscriber service where desired—such as farms, commercial or industrial use in automobiles, trucks, boats and planes.

c) Provide radio-telephone communications between the telephone office and its own mobile units for maintenance operations.

d) Provide quick, automatic service during emergencies (pole-line damage, etc.).

Equipment

The complete base station equipment is housed in a cabinet as shown in Figure 1. It includes a Motorola 60 watt FM transmitter which operates on a frequency of 152.770 mc. A Control Unit consisting of five outgoing tone generators, three incoming tone detectors and all necessary relays, switches, and sensing devices, connects to the telephone equipment. A separate power supply furnishes both high voltage and 48 volts for relay operation, permitting separate operation of the control equipment when desired. The Control Unit is designed to operate from a Strowger, all relay, or cross-bar type telephone exchange.

Two Types of Mobile Service Equipment

For mobile service two types of radio equipment can be furnished a 60 watt or a 30 watt, depending upon the requirement. (In the Florida trial installation both units are being used.) The mobile control equipment unit is designed to mount either with the radio equipment housing or in a separate housing. In order to mount the control equipment within the locked housing the unit was designed on a narrow (1¾ inch) strip which was mounted between the transmitter and receiver. Figure 2

shows one of these units with the cover removed.

The mobile dash telephone is illustrated in Figure 3. The unit has a locking device which prevents the handset from bouncing out of the cradle. An "On-Off" lamp, a busy lamp, and an "On-Air" lamp, are located on the front panel above the dial. A reverting-call push-button switch is located on the left side of the cradle base, and the "On-Off" key on the right side. A buzzer box is used with the telephone and is mounted under the dash panel.

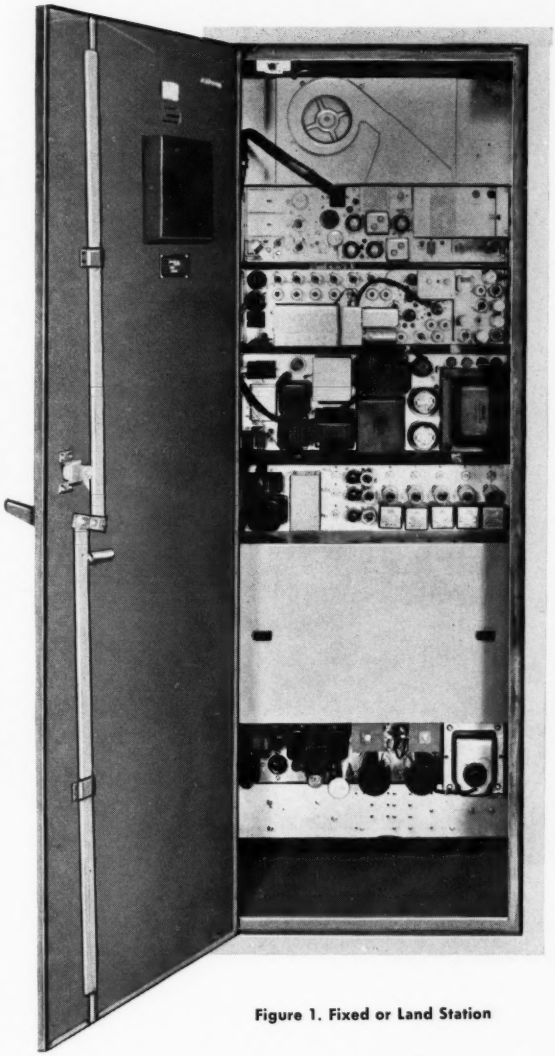


Figure 1. Fixed or Land Station

Figure 2. Mobile Station

Fixed Mobile Station Equipment

The fixed mobile station equipment is similar to the low-power mobile unit, and operates from a commercial power source. It is rated in the 15-25 watt class. The telephone used with this equipment is of conventional appearance and utilizes a regular 60-cycle gong-type ringer. As illustrated in Figure 4, it has the same indicating lamps and "On-Off" switch; however, the reverting-call button has been moved to the cradle under the handset.

Mr. Charles Fawcett, North Florida Telephone Company, operating a Dial Mobile Radiotelephone Dash Unit.

Figure 3.
Mobile Station Dash Unit

Signaling

In a mobile telephone system with a dial at both ends, signaling can be done generally in one of two ways: first, the dial can make or break a tone which modulates a radio carrier; second, the dialed digit can be stored and translated into one or more steady tones, the tone or series of tones differing for each digit 1 to 0. In the new mobile system both methods are used.

Signaling from mobile to base station is accomplished by transmitting a "gate" frequency (2000-cycles) when the dial is taken off normal, and a pulse frequency (1500-cycles) when the dial is released. These tones are received at the base station and are converted directly into DC pulses to select the called land subscriber. This

Figure 4. Fixed-Mobile Station Desk Unit

eliminates a large number of oscillators at the mobile station, together with storage and translation equipment to change the digit dialed into multiple tones. Simplified diagrams of both signaling circuits are shown in Figures 5 and 6.

Signaling from the base station to the mobile unit is accomplished by sending out two tones (between 300 and 500 cycles) to operate a pair of resonant-reed relays at the mobile end. This method is most economical for the small number of mobile stations involved, because telephone equipment effectively translates the dialed number directly into an operation of one of ten sensing relays in the control equipment.

Operation—Land-Initiated Call

When a land subscriber initiates a call, the base radio transmitter is operated when the mobile radio number is dialed (usually on the second to the last digit). Reception of this signal at all mobile units on this channel will operate their busy lamps; this indicates to each mobile subscriber that the channel is in use, but does not prevent him from breaking into an existing conversation if an emergency exists. (If he should break into an existing call, he cannot release the circuit on hang-up.)

The called ringing voltage, usually selected by the last digit dialed, will operate one of the ten sensing relays in the control circuit. These relays are resonant vibrating type devices, each of which will respond to only one of the ringing frequencies between 16⅔ and 66-cycles per second. They will select two oscillator frequencies corresponding to the number of the subscriber being called, and place them on the radio carrier, in pulses corresponding to the ringing periods of the exchange.

In the mobile unit of the called subscriber, reception of these tones will operate two resonant relays which in turn will operate the buzzer. When the mobile subscriber answers by lifting his handset from the dash unit, this automatically places

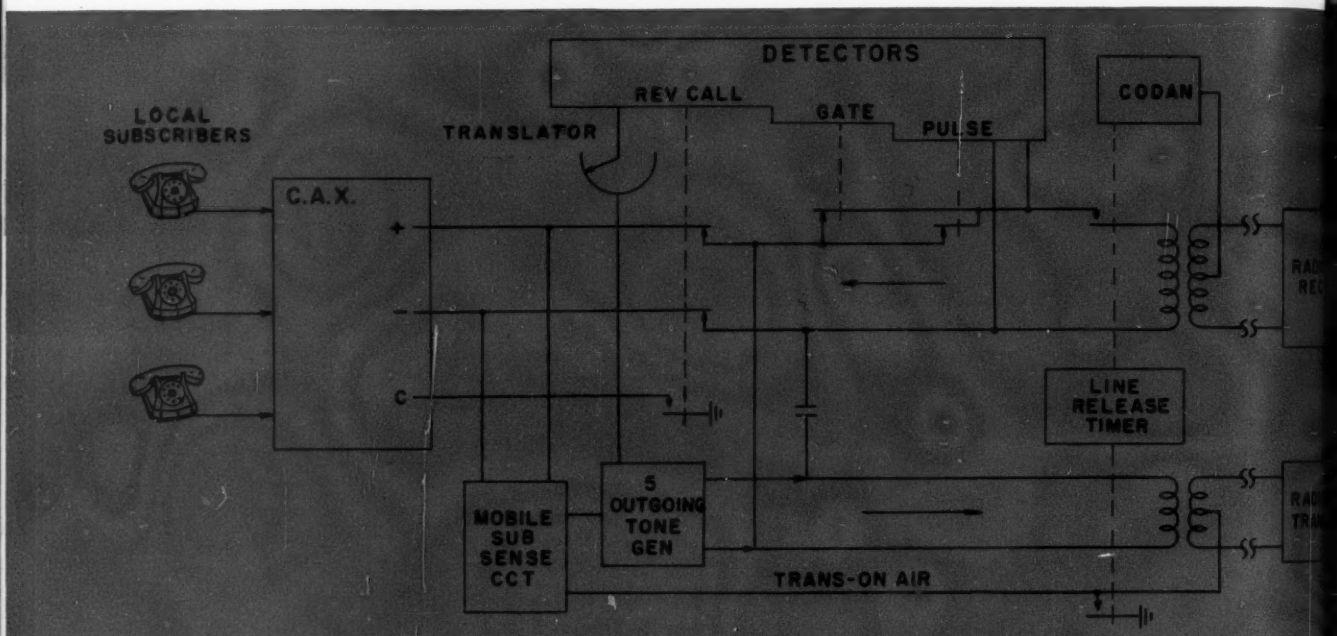


Figure 5. Block Diagram of Land Station

his radio transmitter on the air for 2 seconds. This brief signal at the base station receiver causes tripping of the ring cutoff relay in the telephone equipment, and removes the ringing voltage and tones from the circuit. The circuit is now complete, and conversation can ensue.

If the wire-line telephone disconnects first, the connector will release and start to put the called mobile telephone on line lockout. The auxiliary cut-off relay at the radio equipment will then release, along with the regular central-office cut-off relay. This will open the central office loop and turn off the fixed transmitter without waiting for the disconnect from the mobile subscriber to release the central office loop

and radio channel. Should the mobile subscriber then disconnect after the connection had been released by the wire-line telephone, the fixed radio transmitter would have been turned off and the radio loop already opened, so that the mobile disconnect would not do anything at the fixed radio station.

Operation—Mobile Call

In a "mobile-initiated" call, removal of the handset from the dash unit again automatically places its radio transmitter on the air for a moment. This turns-on the land radio transmitter, and seizes an idle incoming selector in the telephone equipment. Dial tone is returned via this transmitter to the mobile receiver. The mobile

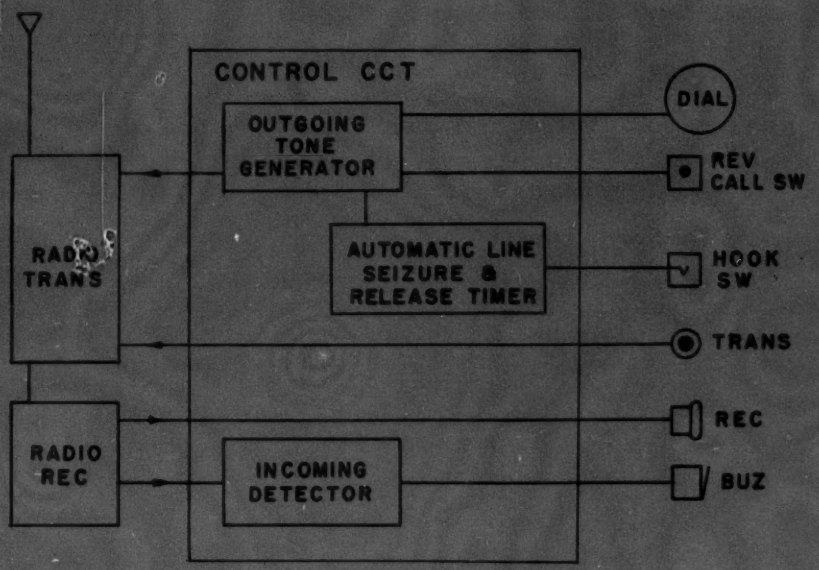


Figure 6. Block Diagram of Mobile Station

subscriber may then dial in the usual way. All tones, (i.e., busy tone, ring-back tone, etc.) which are normally associated with automatic telephone equipment, can be heard by the mobile subscriber.

When the dial in the mobile unit is taken off-normal it turns on the mobile radio transmitter and sends out a tone to operate the "gate" relay in the land station. Because of its slow-release characteristic, this relay remains operated until the end of the pulsed digit; it removes a shunt on the contacts of the pulse relay and permits it to function. When the dial is released the pulse relay follows, and breaks the DC loop circuit into the telephone equipment at a pulse rate. At the end of the pulsed

digit the gate relay falls back to normal. (Note that with this technique, it is necessary that both the long gate signal and the short pulse signals be received before an actual selection can occur at the telephone exchange. False operation of the telephone equipment in a standby condition is possible only if the gate detector were operated by a long period of noise of the proper frequency, at the same time as the pulse detector was operated.) In a reverting (mobile-to-mobile) call the incoming pulses from one mobile station are translated in the control circuit into two tones for selecting the other mobile subscriber.

From the time the mobile subscriber initiates the call until it is answered by the land subscriber, the telephone line is locked in by a 2.5 minute timer. When the land subscriber answers, the timer is disconnected from the circuit, together with the gate and reverting-call detectors, to avoid operation on voice. This is accomplished by the use of a reverse-battery relay on answer.

When the mobile subscriber hangs up, his radio transmitter is again placed on the air automatically, sending a 1500-cycle tone for 2 seconds. Receipt of this "disconnect" signal opens the loop to the central office, and if the "land" subscriber has not hung up, this on-hook signal will merely be displayed back at the connector, so that the connection will not be returned to normal until the land party disconnects. If other mobile stations attempted to call in the meantime, they would merely land on the already established connection, and hence not receive dial tone. This corresponds to what happens on wire-lines.

Time-Out Equipment

To guard against failure to receive a disconnect signal from the calling party (if the line is in trouble or the calling party does not restore handset properly) which would result in tying up the radio channel with the transmitter turned on, it is necessary that the connectors serving the radio channel be equipped with connector "time-out" equipment. The timing equipment at the radio station is of no help on incoming calls to the mobile stations, because the central office connector blocks the calling party's supervisory signals from being received at the radio station (which is now on the called party's end of the connection).

With automatic time-out provided in the connector group serving the radio channel, any trouble condition resulting in failure to receive a disconnect signal from the operator's office or interoffice trunk will be timed-out—provided, of course, that the radio channel shows on-hook. In other words, trouble conditions on wire-lines or on trunks cannot tie up the radio channel for more than the connector time-out period.

Reverting Call

If the mobile subscriber wishes to make a reverting call, he presses the reverting call button on his dash unit for a moment. This places the mobile transmitter on the air with 2500-cycle tone. At the base station reception of this signal busies out the radio circuit to any other land subscriber, and prepares the reverting-call translater. The mobile subscriber now dials two digits—either 01 to 00, or 11 to 10; the first digit selects the ringing code, and the second digit selects the two ringing tones. When the second mobile subscriber answers, the tone generators and detectors are removed from the circuit, and the calling party has power to release the circuit. In this type of call, one of the two mobile units must transmit every 2.5 minutes to prevent the system releasing on the timer.

Since automatic time-out is provided at the land radio-station for outgoing calls, it is necessary for the mobile station to hang up after dialing an operator for a toll call; the operator must then call back to eliminate this automatic time-out feature, which would otherwise open the connection prematurely. This is due to the fact that the operator trunks cannot reverse the calling party's battery supply; if the mobile station attempted to hold the original connection, it would be automatically timed-out and disconnected. Instead, the operator would advise the mobile station to hang up, and would then wait for the disconnect signal before attempting to dial back the station. If this particular disconnect signal should be lost, the operator would continue to hold the circuit until the radio time-out provided the disconnect signal automatically.

It is also possible to eliminate this call-back requirement by having the mobile subscriber press his talk-to-listen switch momentarily every 2.5 minutes. This causes the automatic timer to reset to zero and start a new timing cycle. On calls of this type, the gate and reverting call detectors are removed from operation after a 30-second delay, to prevent their operation on speech.

In accordance with FCC requirements the call letters of the base station are transmitted at the end of every transmission. These are transmitted in Continental Code at a speed of 25 words per minute. One of the outgoing signalling oscillators (500 cps) is used as the tone source.

Conclusion

Since the development work on this project was started, a large amount of interest has been shown and many new uses considered for this type of telephone system. There seem to be many places where it might be used to great advantage, either as a way of offering quick, temporary telephone service, or in places where telephone service does not warrant the expense of poles and wire. Just as microwave circuits can eliminate outside plant between urban areas, so can an automatic radio-telephone system of this type eliminate outside plant *within* a rural area.

ROBERT P. DIMMER started with Automatic Electric in Quality Control in 1939 and was transferred to Laboratories a month later. He became a project engineer in 1947 and a senior project engineer in 1954. Now in the Product Design section of General Telephone Laboratories, Mr. Dimmer is actively engaged in the design and application of transistorized negative-impedance voice repeaters, and the design of control equipment for mobile radio-telephone systems. Mr. Dimmer was graduated from Northwestern University in 1950, with the degree of Ph.B. in Mathematics, and is a senior member of the Institute of Radio Engineers.

a review of MODERN

Outdoor Booth in the Municipal Parking Lot at Harrisonburg, Va.

PAYSTATION SERVICES

By L. L. RUGGLES,

Chief Telephone Engineer,

Automatic Electric Company

Coin-type telephones have been used as public telephone stations for many years. The instruments employed for the collection of charges for local and toll service have a long history of progressive change in design and operating methods. There have been devices for receiving and storing a single coin or as many as five coins from a nickel to a silver dollar. One single-coin device became known as a "nickel grabber" because there could be no return of a coin after it was deposited. The "no return" practice still has a place in telephone operations, but the nickel is fast losing out to the dime or its equivalent of two nickels.

The operation of paystations in an automatic telephone system posed some interesting problems for designers and engineers, who have developed central office equipment and coin-type telephones with the automatic features suitable for operation with automatic telephone equipment. These developments over a period of years are the basis for the apparatus and equipment currently available for commercial use in public paystation service.

There are now a number of methods employed to render public telephone service and to collect charges for use of the service. Automatic Electric Company has made available the telephone instruments and the central office equipment in a number of forms to make paystation service practical and profitable under a variety of conditions. The equipment and instruments which provide these services may be combined into paystation service systems to render the following services:

1. Postpay service (Manual)
2. Semi-postpay service
3. Local prepay service
4. Prepay service
   (a) Conventional type
   (b) Line-number type

The type of service which may be appropriate for a given situation is dependent upon the number of stations involved, the amount of revenue anticipated, the location of the community, and the type of cus-

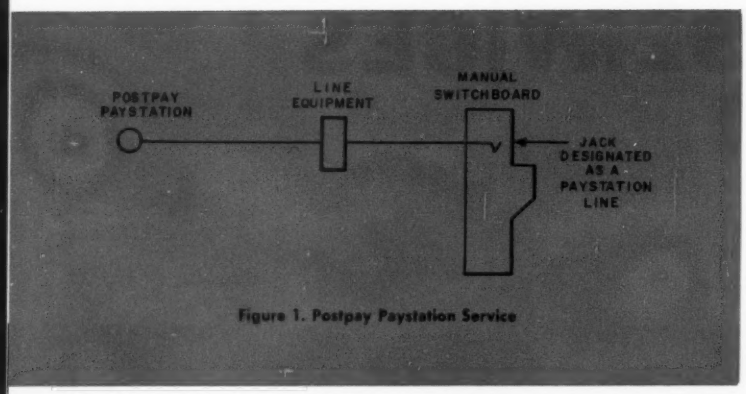


Figure 1. Postpay Paystation Service

tomers to be served. The following discussion will attempt to put into proper perspective the application and economics of each of these general classifications.

No attempt will be made herein to describe in detail the complete physical or electrical components of all the telephones or coin devices used in these systems. Those details may be obtained from catalogs. Our objective is to describe the over-all operating procedures and the central office equipment which apply to each service; such a comparison of features and relative amounts of equipment and apparatus may be helpful in making a selection of the system which most closely fits an individual situation.

Postpay Service (Manual)

This name is applied to a paystation operation which requires the service of an operator on all calls originated by the coin telephone (see Figure 1). In a manual system, all local and toll switching is done by an operator, who requests the deposit of coins to cover the charges after the called party is on the line. Coins drop over gongs to produce tone signals by means of which the operator can determine the number and value of coins deposited. Coins then drop into the coin receptacle and cannot be returned. No special central office equipment is needed.

As part of new operator training, it is necessary that she learn to recognize the different tones of coins deposited into a paystation by the subscriber. Automatic Electric has two units which can be used for coin demonstration—the Type MCF (Multi-Channel, Fixed) Recorder-Announcer, and the SCC (Single Channel, Compact) Recorder-Announcer. (An article on these two units appears in the December, 1957 issue of the Technical Journal.)

Semi-Postpay Service

Semi-postpay paystations were designed for service in a dial system. The term "semi-postpay" is applied to distinguish a dial postpay paystation from a manual postpay paystation. In both the manual and dial instruments it is important to deposit coins *only after* the connection has been established to the called station. Failure to observe this procedure results in deposits being collected—and not returnable.

Semi-postpay service was developed as an economical method of providing public dial telephone service in either attended (Figure 2) or remote unattended offices (Figure 3). No special central office equipment is required, except for a means of identifying a paystation to toll operators. This identification is usually provided by a tone projected over the trunk to the operator when she answers a call. For this purpose the line circuits assigned to semi-postpay telephones (see Figure 2) are equipped with tone condensers which supply a tone over the "C" lead to the CLR trunk, having control relays to impress the tone momentarily on the trunk to the operator, when the call is answered.

The semi-postpay telephones may be assigned to any tone-equipped line in the office; the coin-telephone traffic mixes with other traffic from stations assigned in the same group.

The connector terminals assigned to paystation telephones should be in the preferred series of numbers for toll purposes. The 9000 series is the preferred assignment, although the 7000 and 8000 series are sometimes used. This is important in toll service to operators trying to complete inward collect calls.

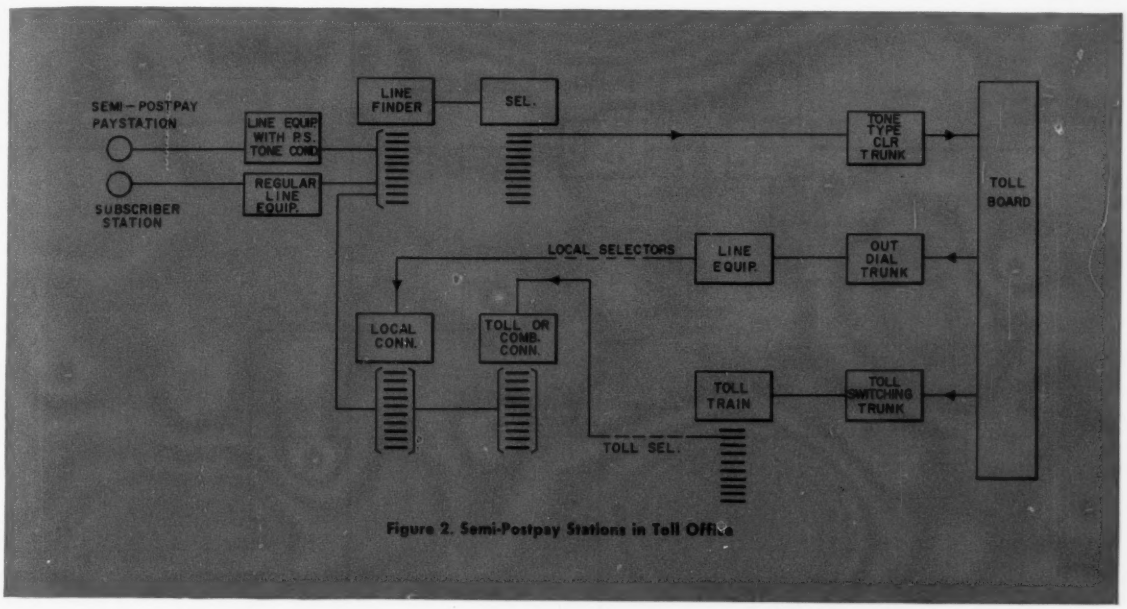


Figure 2. Semi-Postpay Stations in Toll Office

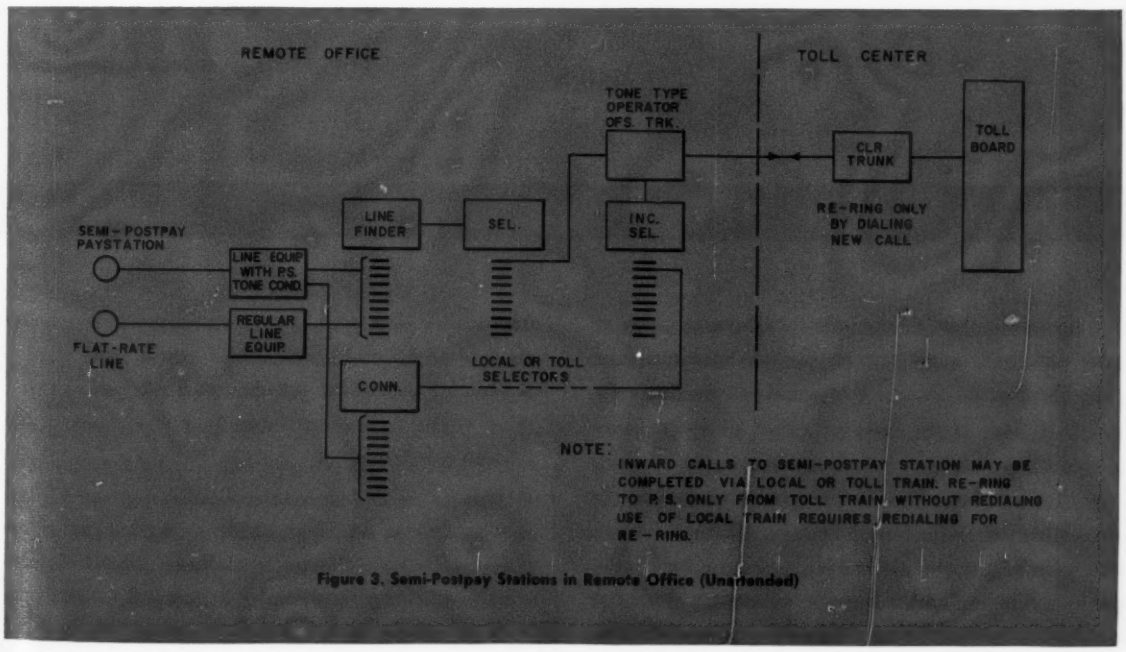

REMOTE OFFICE
TOLL CENTER
TONE TYPE OPERATOR OFS. TRK.
CLR. TRUNK
TOLL BOARD
RE-RING ONLY BY DIALING NEW CALL
SEMI-POSTPAY PAYSTATION
LINE EQUIP. WITH P.S. TONE COND.
REGULAR LINE EQUIP.
FLAT-RATE LINE
LINE FINDER
SEL.
INC. SEL.
CONN.
LOCAL OR TOLL SELECTORS
NOTE:
INWARD CALLS TO SEMI-POSTPAY STATION MAY BE COMPLETED VIA LOCAL OR TOLL TRAIN. RE-RING TO P.S. ONLY FROM TOLL TRAIN WITHOUT REDIALING USE OF LOCAL TRAIN REQUIRES REDIALING FOR RE-RING.

Figure 3. Semi-Postpay Stations in Remote Office (Unattended)

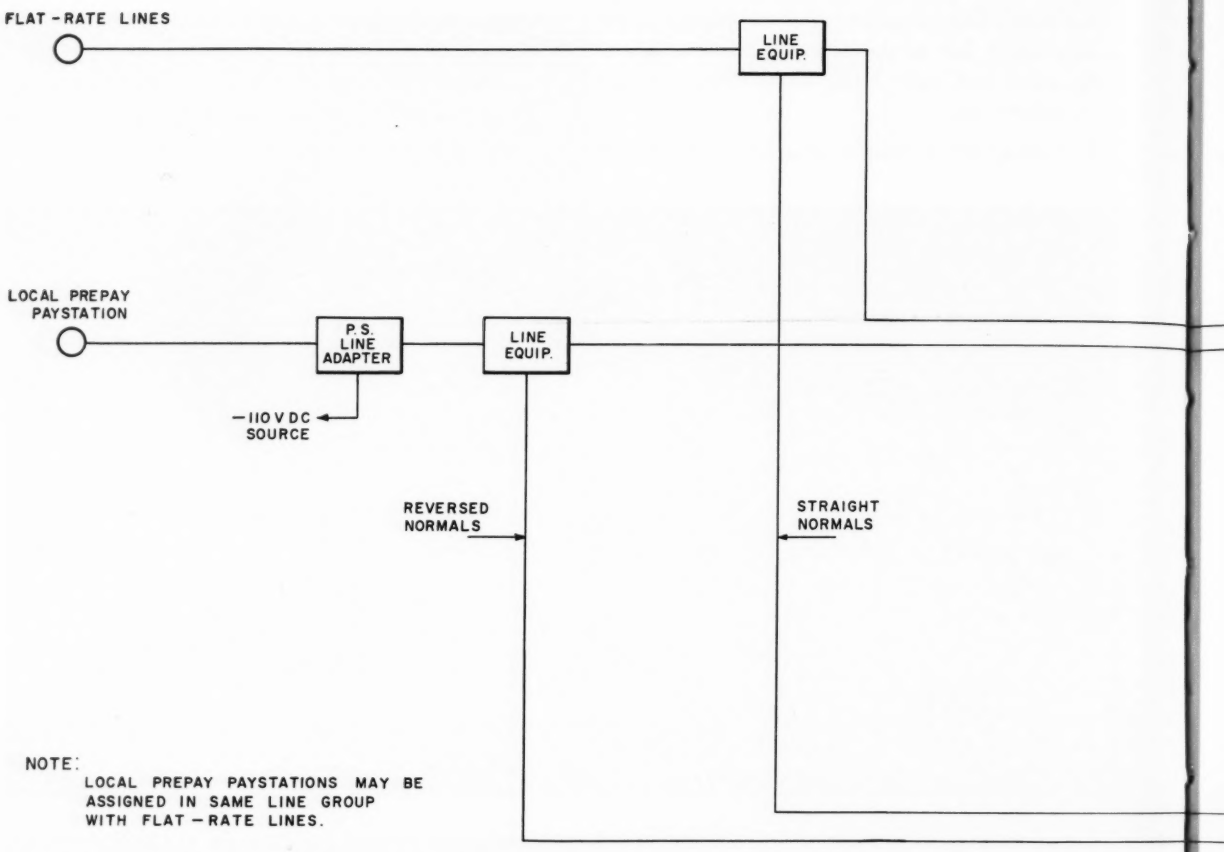
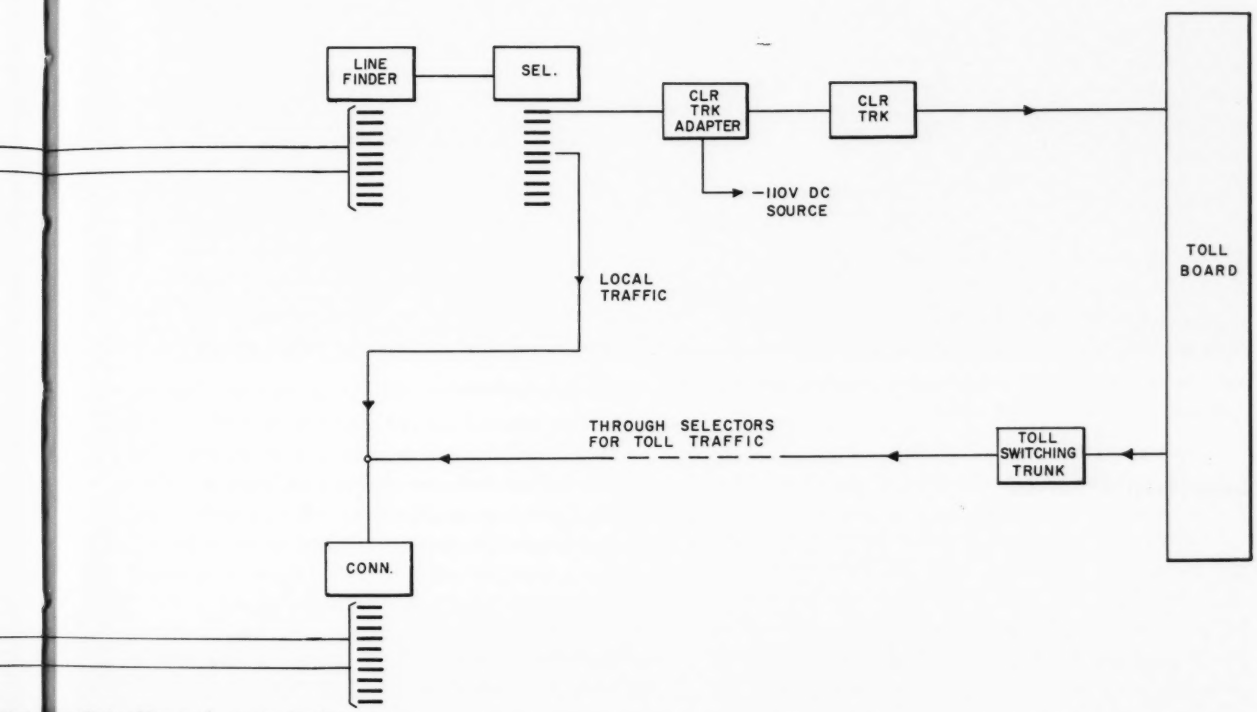


Figure 4. Typical Trunking and Equipment

The mechanism in the coin telephone consists of two polarized relays, which provide the necessary controls. For local calling, the user simply dials the called station; at the time the called station answers, a reversal of the regular exchange battery will operate one of the polar relays, to place a shunt around the transmitter of the calling telephone. The caller hears the called party but cannot reply, until a coin is deposited. The coin trips a spring to remove the shunt around the transmitter of the paystation, thus clearing the transmission path for two-way conversation. At the end of the conversation, the central office battery is restored to normal polarity, and the second polar relay in the paystation restores the mechanism to its normal condition.

This method of operation requires prompt deposit of a coin, to avoid the possibility that the called party may decide the caller has abandoned the call. Where a ten-cent charge is made for a local call, it is recommended that a dime only be used to establish the



Equipment for Local Prepay Paystation Service

talking path. The time required for dropping two nickels may result in the call being lost—and the coins cannot be returned.

No charge is made for calls to special-service operators, such as Information, Repair, etc. The trunk circuits to the special-service desks do not reverse the battery supply when the attendant answers; therefore, no coin deposit is required. It is also generally possible for paystation users to call telephone company official stations without charge; the connectors in the group which serves these official numbers will not return reverse battery to the calling line from terminals on levels assigned to official stations.

The CLR trunks to the toll board do not reverse battery to the paystation telephone when the operator answers the call. The polar relays in the telephone do not operate, so a clear transmission path is established. All coins deposited drop over signal gongs for operator supervision, then directly into the coin receptacle. *No coins can be returned.*

If toll trunks are arranged for re-ring, it is possible to re-ring the calling paystation at the end of a conversation. If no re-ring feature is provided, it is necessary for the operator to initiate a new call by dialing the station number to request an additional charge for overtime conversation.

Inward calls to the semi-postpay station may be completed via either the local or the toll train. In the latter case, the paystation may be re-rung without re-dialing; use of the local train, however, requires re-dialing for re-ring.

In unattended offices (see Figure 3), the operator office trunks are provided with tone-control relays. They will project the identity tone of the paystation line to the toll operator at the time the operator answers the call. Otherwise there is no special equipment required in either the remote office or at the toll center. (To re-ring a paystation, in this case, the operator must re-dial the call.)

Local Prepay Service

In city areas—particularly in the larger ones—prepay paystations (described later) are most commonly used. However, travelers from these city areas into fringe areas or rural communities now often encounter public paystations which are operated on a postpay or semi-postpay basis. Failure of the user to read instruction cards may lead to delays, loss of calls, and frequently to loss of coins (at least temporarily).

Semi-postpay operation has long served a useful purpose in providing public telephone convenience at a reasonable cost which could be justified by the revenue created. Unfortunately, the difference between prepay and semi-postpay service is becoming more noticeable and annoying as more users are encountering both types of service. This annoyance is also reflected in telephone operating administrations.

These factors have led to the development of a system which eliminates the contrast between the two plans, as far as the user can tell. The new development has been called the "Local Prepay Paystation System" for dial service. The coin-type telephones are arranged for 5- and 10-cent operation for local calls.

As the name implies, the coin telephone functions as a prepay telephone for local dial calls; postpay for toll calls. A coin deposit is required before dialing can proceed. Coins are automatically returned when a busy line, or a "no-answer" condition is encountered, and are automatically collected when the called party answers.

It is anticipated that the principal application for the Local Prepay System will be in the smaller offices which may require only a few paystations. For such applications the lines serving local prepay stations can be assigned in any line group (see Figure 4), but will be terminated on auxiliary relay circuits (line adapters). These precede the standard line equipments and control the automatic coin return and collect functions. The line adapters are connected to a source of —110 volts, d.c., for coin return and for resetting the coin mechanism. Regular 48-volt central-office battery provides the source for the collect function.

Note that only —110 volt d.c. is required, whereas in the conventional prepay instruments both — and + 110V. independent sources are employed. The —110V. potential can be obtained by using a —60V. booster battery to supplement —48V. central office battery; it may be desirable, however, to employ a rectifier supplying only —110V. from commercial power, or from some other available source.

The coin mechanism in the paystation telephone is arranged to collect deposited coins with reversed battery (48V.) from the local connector as soon as the called party answers. At the termination of the local call, with the paystation receiver "on hook", the line adapter impresses —110V. on the paystation line to restore the mechanism to normal. The —110V. source is also employed for the automatic return of coins when the caller encounters a busy line or no answer.

The coin telephone instrument used for Local Prepay service contains a new combination of electrical and mechanical components. The 48V. collect magnet is used to trip a locking detent, which releases the trap vane for directing coins into the coin receptacle. The 110V. refund magnet (responsive to a pulse of —110V., d.c.) will operate the vane to the opposite position, for return of coins, and will hold it in the coin-return position as long as —110V. is impressed on the line. The trap vane will restore to its horizontal position under spring loading, and lock in normal position, when the —110V. is removed from the line.

Outdoor Booth Installed in a Suburban Area as a Public Service

The coin mechanism is returned to normal position after each call by the application of a pulse of —110V. to the line from the special adapter.

On inward calls, the coin mechanism always operates to the collect position by reverse battery (48V.) from the connector back bridge, through reversed normals to the line. Upon completion of the inward call, the line adapter automatically impresses —110V. on the line to restore coin mechanism to normal position.

To insure ample current supply to the 110V. magnet, spring contacts on an auxiliary relay in the ringer box connect both line conductors together to provide the lowest possible resistance path from the central office for the —110V. operating current. This auxiliary relay does not operate on 48 volts because of a series neon tube which will not break down on that voltage. The neon tube also prevents a normal leak to ground.

Operation on Toll Calls

The method of operating the Local Prepay paystation on a postpay basis for toll calls permits coin and non-coin service over regular toll trunks; this provides a less costly arrangement for a small group of paystations. It also permits the same procedure for initiating a toll call as for a conventional prepay station.

With the handset off the hook, dial tone from the central office is returned when a local trunk is available. This assures a clear circuit to central office equipment before coins are deposited. The dialing circuit is blocked until a dime or two nickels are properly deposited. Following the dialing of the toll operator code, and as soon as a CLR trunk is seized, the original coin deposit is automatically returned; the coin mechanism inside the paystation telephone then re-operates (by reverse battery) to the collect position, under control of the (special) CLR trunk. A class-of-service tone is transmitted to the operator when she accepts the call. The operator establishes a connection with the distant station, and then requests deposit of the coins required to cover the toll charges. The coins drop over the coin signal gongs into the coin receptacle, and cannot be returned; this feature is comparable to conventional postpay operation.

At the termination of an outgoing toll call, the line adapter functions to reset the coin mechanism to normal when the handset is replaced "on hook".

On all inward calls to a Local Prepay station, the coin mechanism is operated to the collect position, so coins deposited for "inward collect" toll calls will

drop directly into the coin receptacle. The connector normals to the paystation lines are reversed so that the battery supply to the local prepay paystation is opposite in polarity to the normal supply. At the termination of an inward toll call, the line adapter impresses —110V. on the paystation line to restore the coin mechanism to normal.

At present it appears that in most installations the Local Prepay paystations will be assigned to line equipments in the same linefinder group, or groups, with regular station lines. The paystations and the other stations assigned to the common group will, therefore, use a common group of trunks to the toll board for toll service. Because standard CLR trunk equipments are not designed to perform functions required to operate coin mechanism in Local Prepay Station telephones, auxiliary equipment has been developed to supply the following additional features:

1—Automatically return the initial coin deposit, as soon as the CLR trunk is seized.

2—Restore the coin mechanism to the collect position after the return operation has been completed, so coins subsequently deposited as requested by the operator will drop into the coin receptacle.

The coin return is accomplished within the adapters (auxiliary relays) by impressing a timed pulse of —110V. current on the trunk toward the paystation. This is followed by a reversal of 48-volt battery supply to re-set coin mechanism to collect position.

The CLR trunk adapter includes a tone detector which will recognize the paystation tone connected to the line equipments that are assigned for paystation use. Upon detection of the tone, the adapter circuit is conditioned to perform the operations described above.

When a regular station is connected to the CLR trunk, there will be no tone supplied; therefore, the adapter will not impress the —110V. current back on the line but will complete the connection through to the regular CLR trunk, to signal the operator. The 48V. battery supply to the calling line will, however, be reversed, just as it would be for a connection to another local line.

For normal complements of CLR trunks, adapters may economically be added to all CLR trunk equipments. When the number of CLR trunks required is unusually large, it may be found desirable to group paystations separately, and give them access to only a portion of the CLR trunks, to which adapters are then applied. An engineering analysis of the individual situation should be made to determine the best procedure.

It should be noted that combined groups of coin and non-coin lines present a problem in offices connecting with Bell CAMA equipment, as the CAMA operator has no way to receive class-of-service tone from paystations. It is therefore necessary to block paystation calls from access to CAMA trunks. Where SATT equipment is employed, the identifying operator will receive class-of-service tone, and can advise the paystation user to dial the long-distance operator for long-distance calls, instead of using the SATT code. It is possible, however, with proper central-office equipment, to block individual paystations or groups of paystations from reaching CAMA or SATT trunks. This latter arrangement is probably the most satisfactory because it eliminates the possibility of unauthorized SATT or CAMA calls.

The cost of Local Prepay paystation service is sufficiently below the cost of conventional prepay service to make it attractive for installation in tributary offices. And its advantages appear to justify its application in many locations, especially in small exchanges where toll traffic from the paystations is light (heavy toll traffic in some locations may, however, necessitate full prepay service). It is also possible to convert a semi-postpay telephone to Local Prepay type if it should appear advantageous to upgrade the existing service being rendered by semi-postpay operation.

Prepay Paystations (Dial)

A Dial Prepay Paystation telephone requires a deposit of one or more coins to initiate a call. The coin mechanism will collect or refund coins when actuated by coin-control-type central office equipment. The following coin collect and refund operations are completely automatic when local outgoing calls are made from the station:

a) Coins are returned automatically when a busy signal is encountered, but only after the handset is "on hook".

b) Coins are collected upon the completion of a local call, after the handset is "on hook".

c) Coins are returned with the handset "on hook", when no answer is received from the called station.

For outgoing toll calls from the prepay station telephone, operation of the coin mechanism is partially automatic and partially under control of a toll operator. The initial coins are returned automatically when a toll operator answers a call dialed to the toll board. After the operator answers a call from a prepay station telephone, she assumes control of the coin mechanism for collect or refund functions.

When a conversation is completed and the paystation telephone handset is "on hook", operator's disconnect will cause the mechanism to drop the deposited coins into the coin receptacle. If a call cannot be completed by reason of a busy line or no answer, the operator can cause deposited coins to be returned by operating a position coin-return key.

If there appears to be an error in the number or value of coins being deposited, the operator can return the coins for re-deposit. If the number of coins required for a long-distance call exceeds the capacity of the coin hopper, the operator can make a partial collection before asking for the balance.

It has been common practice for a toll operator, dialing an inward collect call to a prepay paystation telephone via a coin-type toll switching trunk, to control the collection of coins by operating a coin-collect key on the toll position. However, later designs of toll switching trunk equipment provide for automatic collect of coins with the paystation handset on the hook when the operator disconnects from the toll switching trunk jack.

There are currently two types of prepay paystation telephones; one requires only one nickel to initiate a call, the other requires one dime or two nickels. In both types, coins must be deposited before the dial can transmit impulses for operation of the central-office switching equipment.

There are two schools of thought about when the user should receive dial tone:

1—Prescribes that dial tone be withheld from the calling coin telephone until a coin or coins have been deposited.

2—Provides for a dial tone to the user immediately after the central office equipment has been seized upon removal of the handset from its hook—*before* deposit of coins.

Plan 1 has its virtues, but also has potential for unfavorable user reaction. If after coins are deposited no dial tone is returned, due to no circuit or a congestion of traffic in central office, there is no way of returning coins; thus, user may lose his deposit.

Plan 2, advocated by Automatic Electric Company, provides for dial tone to the coin telephone when a circuit is completed to the central office after removal of the handset. This assures that coins deposited can be returned if the call is abandoned. In "two nickel or one dime" telephones, if the first nickel is deposited and call is abandoned for lack of a second nickel, the first coin will be returned automatically.

Success or failure of either plan depends upon proper use of paystation telephones. Instruction cards, easy to read and understand, are essential.

In any case, with Plan 2, if the user waits for dial tone before depositing coins, he may be confident of completing his call. If no dial tone is received, he can assume the line is out of order and he should not deposit coins. Without this provision it is conceivable that consecutive attempts by a number of users in emergencies could cause the coin mechanism in the telephone to be jammed, thus requiring a repair man to clear the instrument.

Central Office Equipment for Conventional Prepay Paystations

The control of the coin mechanism of the dial coin telephone in prepay service is the function of relay groups, associated appropriately with the automatic switching equipment in the central office. The number of prepay paystations to be served, and the amount of traffic expected, determines the arrangement and type of trunking equipment that will serve these stations most economically.

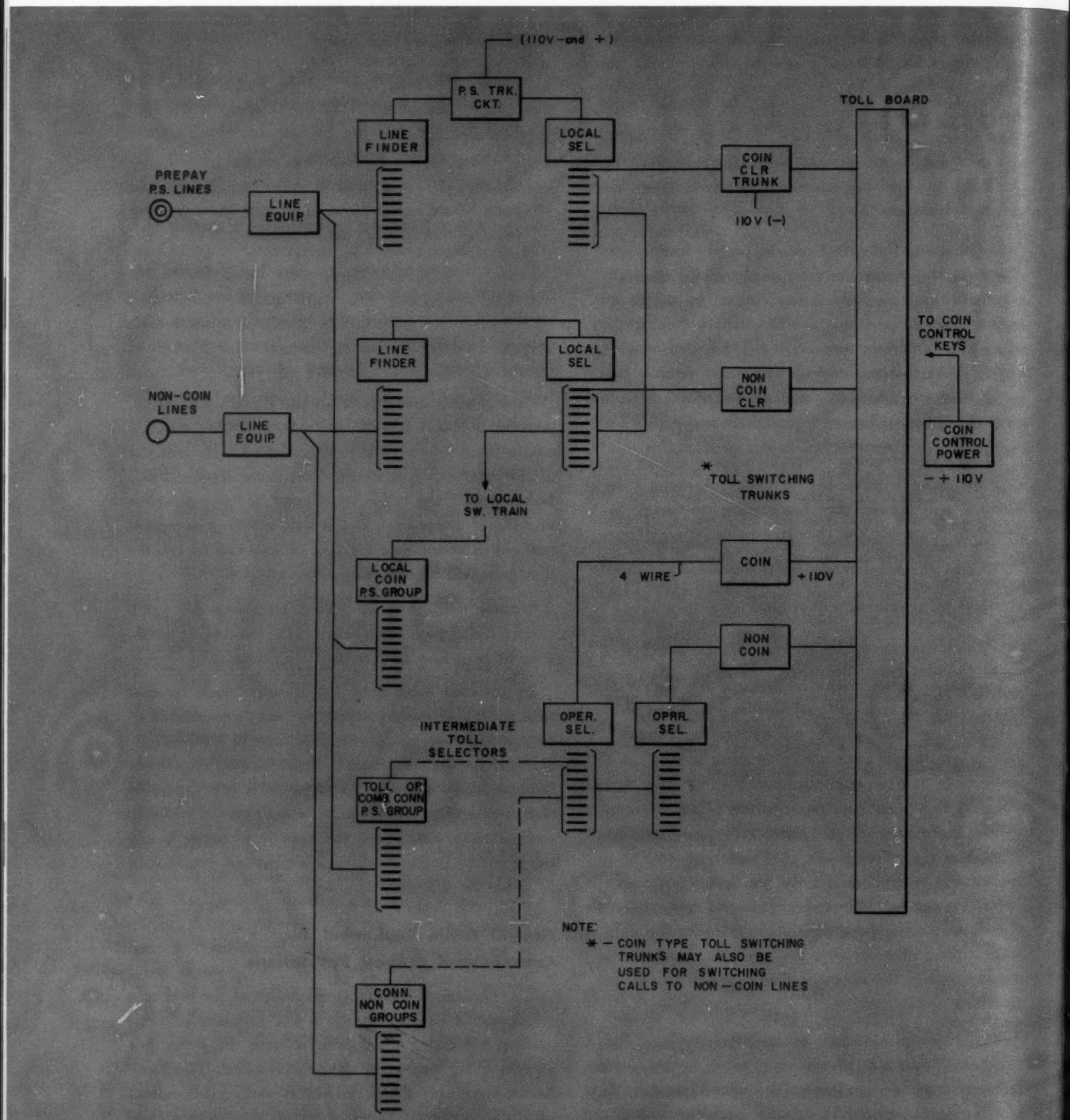


Figure 5. Conventional Prepay Paystation Service in Toll Center

There are two basic methods by which prepay paystation service may be rendered from the conventional prepay telephone. The method chosen is based on a number of factors, the most important usually being the potential return on the investment necessary to install suitable central office facilities.

Paystations Served by Equipment Associated with a Toll Board in the Same Office Area

For the moment we shall confine this discussion to the conventional prepay type of paystation service for stations connected in a toll center office, where the toll board is located in the same or a nearby building. An alternate method will be described later.

With the conventional system (see Figure 5) it is necessary to assign the paystations to a segregated group of line equipments, served by a separate group of linefinders and first selectors. The trunks between the linefinders and selectors are equipped with relay groups known as paystation repeaters or paystation trunks. On local outgoing calls, these relay groups alone control the coin mechanism in the telephones. For toll calls, there are required the auxiliary services of a separate group of coin-type CLR trunks from the segregated group of first selectors, and certain operator controls as previously described.

Toll board position and cord equipment provide the means of control by which the operator can effect collection or refund of coins at the station via the coin-type CLR trunk, through the paystation repeater and the line to the station.

Figure 5 also shows the facilities for extending an inward toll call from the toll board to the paystation, through coin-type toll switching trunks (which may also be used for switching calls to non-coin lines). These coin-type trunks represent current practice for providing automatic coin-collect after the inward collect call has been completed; disconnect by the operator causes the toll switching trunk circuit to impress collect battery on the coin mechanism of the called paystation. Earlier designs required the operator to initiate the collect operation by operating a coin-collect key. The coin-return key on the toll positions is used to manually control the return of coins when necessary.

The source of power used to control the telephone coin mechanism consists of batteries or a rectifier which will supply 110-volts d.c. of negative and positive potential with reference to ground.

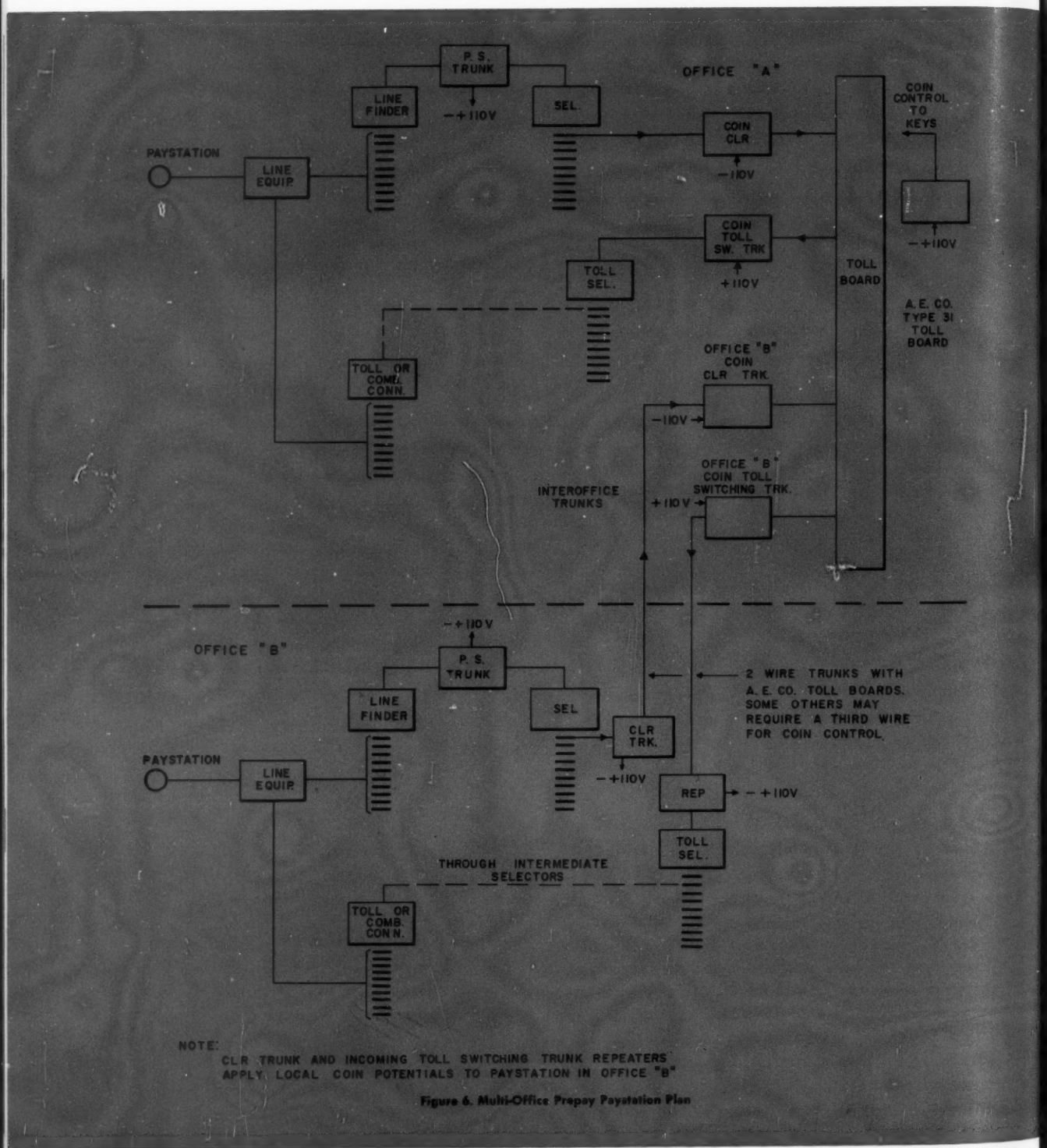
The coin mechanism in the telephone consists of a two-coil electromagnet, polarized by a permanent magnet for operation of a center-pivoted armature which is linked mechanically to a center-pivoted vane at the bottom of the coin hopper. The application of negative or positive 110-volts d.c. to the connected line results in the tipping of the hopper vane in opposite directions, permitting deposited coins to fall into the coin receptacle or into the return chute as required. No attempt will be made here to describe the details of this mechanism, since such details have been described in other publications.

Paystations Served by Equipment in Offices Remote from the Toll Office

In a multi-office exchange where prepay service is offered, the operating methods are the same as described. For control of the coin mechanisms in paystations served by remote offices, however, some additional facilities are required in the central office, because the combined resistance of an inter-office trunk and the paystation line to the remote office is generally too great to permit sufficient operating current to flow from the central-office 110-volt source for operation of the paystation coin magnets.

The facilities provided by Automatic Electric Company consist of coin CLR trunks and toll switching

In Trailer Parks, One Paystation Serves Many Users



NOTE:
CLR TRUNK AND INCOMING TOLL SWITCHING TRUNK REPEATERS APPLY LOCAL COIN POTENTIALS TO PAYSTATION IN OFFICE "B"

Figure 6. Multi-Office Prepay Paystation Plan

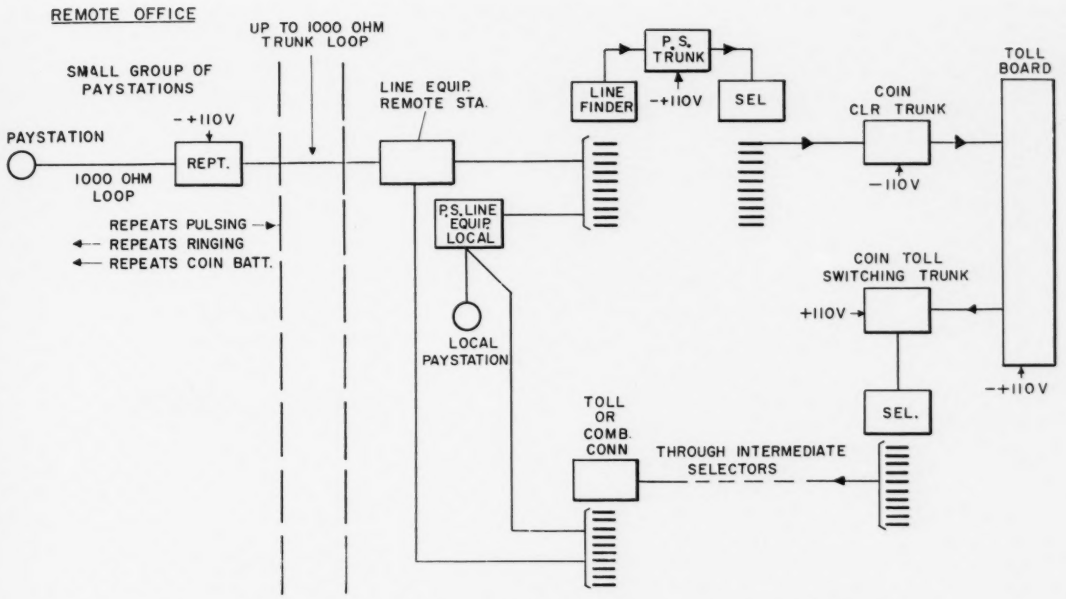


Figure 7. Prepay Paystations in a Remote Office Terminated on Line Equipment in Toll Office

trunk circuits (see Figure 6) which will receive the coin-control power from the toll office and impress local coin-control power on the line. These trunk circuits are referred to as "coin-battery repeating" types. They permit the use of two-wire trunks between a remote office and the toll office—unlike three wire trunks (in which the third wire is used to control the remote office equipment for coin collect or refund functions).

Paystations in C.D.O.'s or Other Unattended Offices

There are some conditions under which it may be desirable to provide prepay paystation service to a few stations in a C.D.O. or sub-office (unattended) where the offered paystation calls are predominately toll calls or local calls to the main office. If the line circuit to the main office is within the office limit, the paystation can be connected directly to line equipment in the main office paystation group; the paystation terminal number is then within the numbering system of the main office. No special equipment is required in the remote office.

When the line loop to the main office exceeds 1000 ohms, however, it becomes necessary to equip these remote paystation lines with a repeater which will repeat dial impulses into the main office switches, as shown in Figure 7. The repeater will also impress local ringing current on the local line in response to ringing current from the main office, and will actuate the coin mechanism by applying local coin battery in response to the main-office coin battery under control of the main-office equipment.

If the requirement for conventional prepay paystation service in the remote office exceeds 15 or 20 stations, it may be more economical to assign the paystation lines a local connector terminal number and connect these lines to local line equipments served by a segregated group of linefinders having a capacity of 25 or 50 lines, as shown in Figure 8. The linefinders then are connected to local coin-type trunk equipments, which are terminated in the main office on line equipment in the paystation group.

For outgoing calls, the paystation becomes a line in the main office; for inward calls (usually only toll)

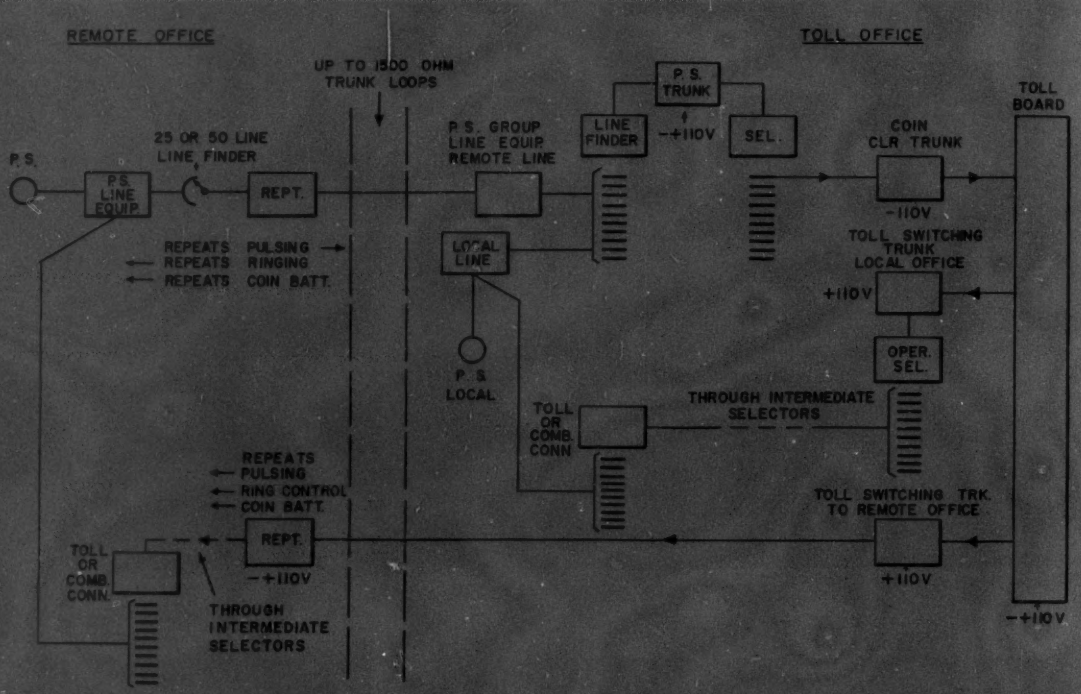


Figure 8. Prepay Paystations in a Remote Office Served by Toll Office Paystation Trunk Equipment

local switching equipment serves to complete the switching to the paystation telephone.

Line-Number Prepay Service

In unattended offices, adjacent to an exchange area served by prepay paystations, there may be requirements for a small group of prepay-type coin telephones. The cost of standard prepay facilities as described may not be justified, but a more economical prepay service can be provided for a small group (up to 25 lines) by a method of operation known as Line-Number Prepay Paystation Service.

This designation stems from the method of coin control provided for toll operators. It is a remote-control type of operation: as shown in Figure 9, the operator uses her position dial to control a two-motion Strowger switch at the office serving the coin telephones (which are standard prepay-type).

This "coin-control" switch, remotely controlled by the operator's dial, has facilities for operating the telephone coin mechanism for collection or return of coins when it becomes necessary for the operator to initiate these operations under any of the following conditions:

1—For outward calls from the paystation, it may become necessary to return coins deposited in error, or for a recheck of coins deposited. (This does not involve the initial coin deposited to initiate the call. The initial coin is returned automatically as soon as the operator answers.)

2—If the quantity of coins required for payment of the call should exceed the capacity of the coin hopper, a partial collection may be necessary.

3—For inward-collect calls to the paystation, the coin-control switch is employed to collect the charges. Should it be necessary to return coins, the switch is also used.

Bank terminals of the coin switch are connected to the line circuits and connector terminals assigned to the paystations. The final two digits dialed by the operator to position the switch wipers are the same as the final digits of the connector terminal numbers assigned to the paystations. This is the basis for the term "Line-Number Prepay Service".

In addition to the final two digits of the terminal number, a third digit is required by the coin switch to condition it for either coin collect or refund operation. For collection of coins, the digit "2" is generally used; for return of coins, the digit "7" is dialed. When the switch has been positioned on the desired terminal and the marking digit "2" or "7" has been registered, the switch will automatically impress the proper polarity of 110V., d.c., on the line to operate the telephone coin mechanism.

As suggested, the coin switch is not required for most outward calls from the paystation. The coin deposited to initiate a call is returned automatically as soon as the operator answers. Furthermore, a normally completed call will result in automatic collection of coins, and if a call is not completed (as a result of a busy line or no-answer), the return of coins is automatic without operator supervision. To re-ring the paystation, the terminal number must be dialed over the regular switch train.

There are two optional provisions for operator access to the coin-control switch:

Option 1—A direct trunk may be assigned from the toll board to the coin switch.

Option 2—A regular out-toll trunk to the trunk selector in the remote office may be used to dial an access level assigned to the

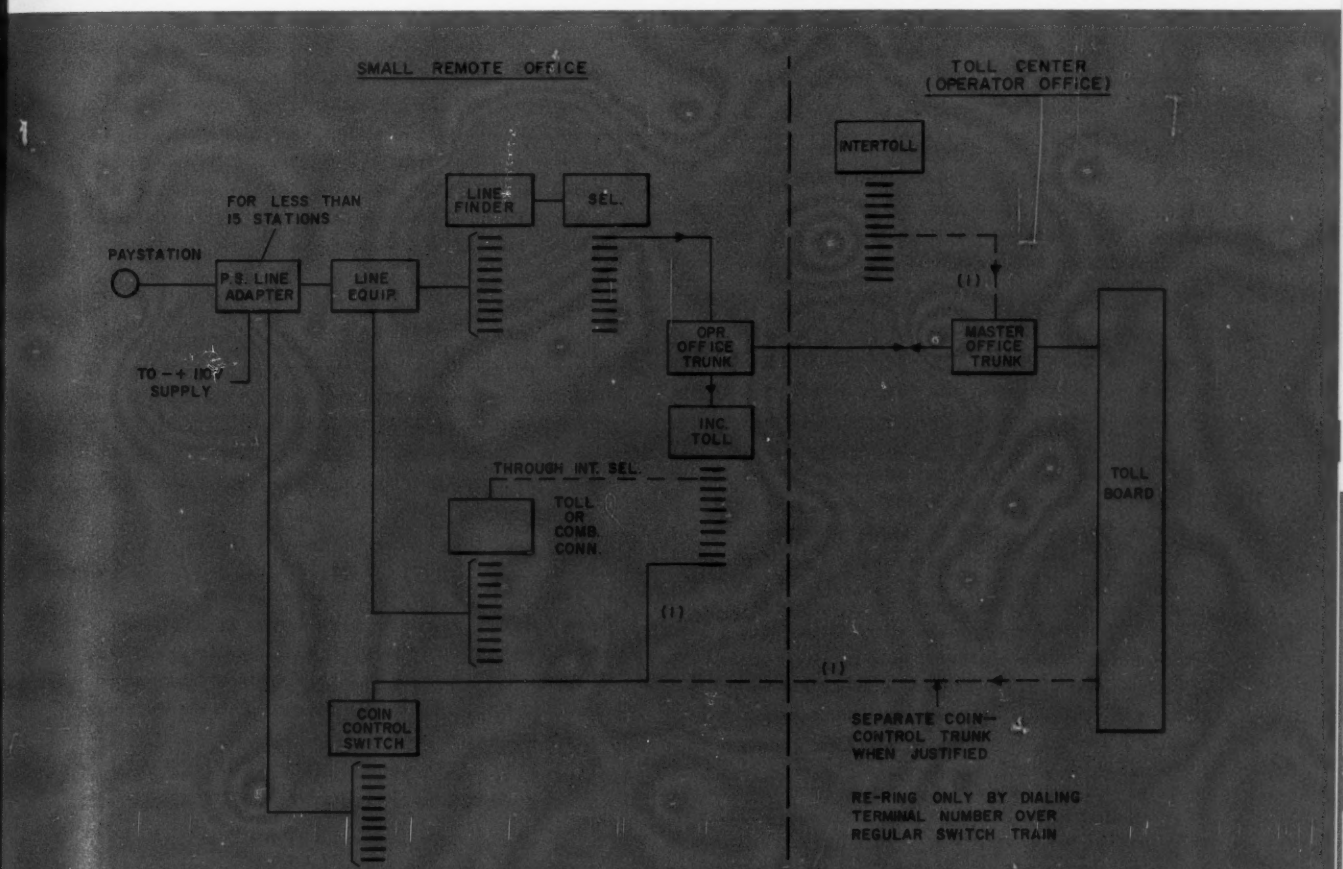


Figure 9. Line-Number Prepay Service with Adapter in P.S. Line

coin switch. To prevent distant operators or customers from operating the coin-control switch, this level should be accessible to the local toll operator only; otherwise, a separate trunk must be used.

With Option 1, the operator need dial only a prefix digit (2 for collect, and 7 for refund), plus two or more digits representing the connector terminal number assigned to the paystation, to position the wipers of the control switch on the terminals associated with any paystation line.

With Option 2, the operator dials an access digit to reach the coin control switch, and then the prefix digit and the terminal digits as stated above. Relay mechanisms in the coin-control switch will then complete the collection or return of coins.

The coin-control switch as currently furnished is capable of absorbing two or three digits before responding to the last two digits of the terminal number to position its wipers. This arrangement permits the operator to use the 4 or 5 numerical digits of a 2L-5N number to reach the connector terminal associated with the paystation telephone.

For all local traffic, the service to the user is identical to that provided by standard prepay paystation equipment. The apparatus which is used for local service, and is also involved in outward toll calls from the paystation, is available in two basic forms.

The original installations employed individual line adapters which were connected to the paystation line ahead of the regular line and cut-off relays (see Figure 9). Containing the relays which control the 110-volt sources for the automatic coin-control functions, these adapters perform the operations in a manner similar to that provided by the paystation trunk circuits used in the conventional prepay system (Figure 5). The adapters can be connected to any line circuit; traffic from paystations is combined with traffic from all other lines in the group.

In order that an operator may distinguish a paystation call from a regular station call over a common group of trunks to the toll board, the adapter is arranged to project a tone over the trunk to the operator when the call is answered. Line adapters have been used for small groups. (See Figure 9.)

In some more recent installations it has been found economical to provide a segregated group of lines to serve paystations on the basis of Line-Number service. Each line is equipped with an auxiliary relay in addition to the regular line and C.O. relay. This segregated group is served by linefinders of the small-group type—single-motion rotary switches of 25- or 50-line capacity (Figure 10).

The finders are connected through a paystation trunk circuit to a selector, in an arrangement similar to that employed in standard prepay service. The trunk circuit contains the coin-control relays which automatically control the telephone coin mechanism on local calls originating from the paystation. They also function to return the initial coins when such calls are routed to the toll board, and to return coins on incomplete calls or collect automatically on completed calls. The auxiliary line relay shown in Figure 10 serves to switch the outside line to the coin-control switch and short the line "in" to hold the circuit during the coin-control operation. This arrangement of Line-Number paystation lines in a segregated group appears to be somewhat more economical than the line-adapter method, for groups of 10 to 25 lines. This observation is based, however, on the actual equipment involved; it does not take into consideration other costs which may vary from one installation to another. Thus, the addition of Line-Number prepay service to an existing office could involve factors —such as available mounting for the separate linefinder group, spare line equipments in existing groups, etc.—which would favor the line-adapter method.

This service has the advantage of a lower cost in equipment and trunks than standard prepay service and gives the equivalent of full prepay service. No special equipment is required on the toll board. The toll operating practices, however, are somewhat more complicated than the standard system and may in some cases control the decision to adopt Line-Number prepay service.

Summary

The selection of a paystation system which will meet the service requirements of a particular set of conditions can be influenced by a number of factors. A review of some of the highlights of each system may help to put the service features and the economic factors in proper perspective.

Standard Prepay Paystation Service offers the most complete service to customers. Its features include:

1—Fully automatic collection and refund of coins on local calls.

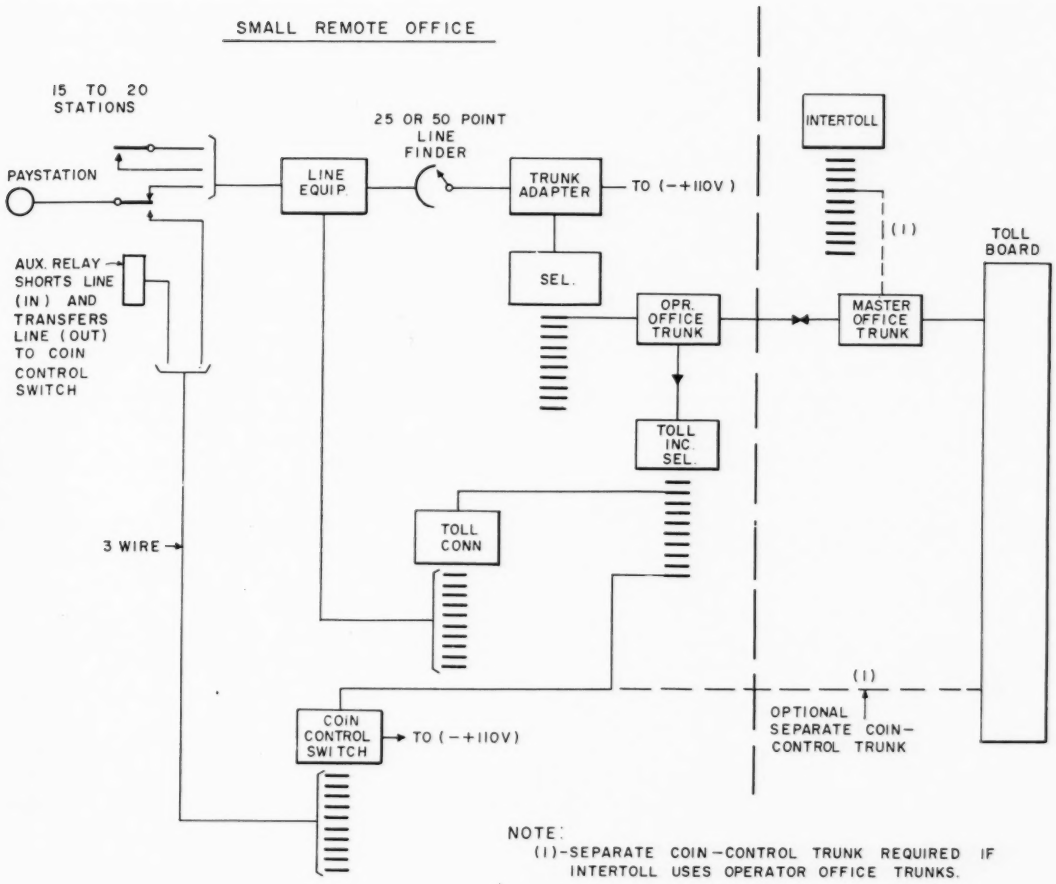


Figure 10. Line Number Prepay Station Service with Paystations in Segregated Group. Adapter in Primary Trunk.

2—Operator control of collect and refund functions for toll traffic.

3—Delayed ringing and re-ring to paystations served by a toll train with a toll board arranged for positional coin control.

Prepay service is predominant in the larger cities, in multi-office systems and to some extent in C.D.O.'s closely integrated with metropolitan areas.

Line-Number Prepay Service is useful for small groups of prepay paystation telephones in unattended offices which serve a part of an area where standard prepay service is offered. The service to customers is equivalent to standard prepay service for local and toll use.

The traffic operating practices for this system do not conform to standard prepay practice. This may have a bearing on its selection.

For a limited number of paystations the investment in equipment can be less than the amount required for standard prepay service under the same set of conditions.

Highway Outdoor Booth Location for Good Will and Public Service

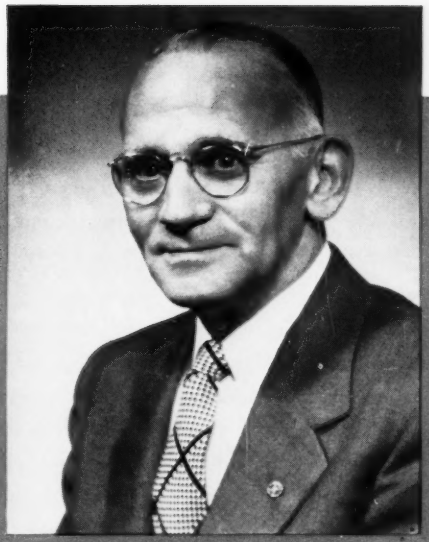
The Line-Number system requires the use of a separate coin-control trunk for greatest efficiency. Or, an alternate method of using any one of the toll completing trunks for access to the remote coin-control switch may be used as illustrated in Figure 9. The standard prepay service for offices remote from the toll center provides for coin control via the regular two-wire trunks for talking.

Local Prepay Paystation Service provides, from the users' point of view, all the advantages of a standard prepay service for local calling. However, toll service is strictly postpay and no refund of coins is possible. Where a toll board is arranged for postpay toll service, no change is required to service Local Prepay Paystations. A toll board equipped for positional coin control for serving some prepay paystations (for example, in the toll center) can, of course, process toll calls from Local Prepay stations. In fact, there are many toll boards now serving both prepay and semi-postpay paystations; traffic operating practice for toll traffic is the same for Local Prepay as for postpay or semi-postpay. No special toll board equipment is required for Local Prepay service, nor special operating practices for the operator.

By comparison with the other two forms of prepay service, Local Prepay service can be provided for a smaller investment in equipment. There are conditions, however, such as the number of stations being served, the amount of toll traffic generated, and the total number of CLR trunks, which will affect cost.

Semi-Postpay Paystation Service in an automatic office is well known in the industry. It serves a useful purpose and is the least costly of all paystation systems—except, of course, the manual postpay paystation. But the contrast between Prepay and Semi-Postpay service in some sections has become a problem for the public as well as for telephone operating company personnel. It will probably bring about a public demand for more nearly uniform practices in paystation operation, particularly in view of the decentralization of industry and the trend of residential development on the fringe areas of large cities.

Where there has been a need for improvement in the art, it has usually been accomplished. Paystation service will probably be no exception.



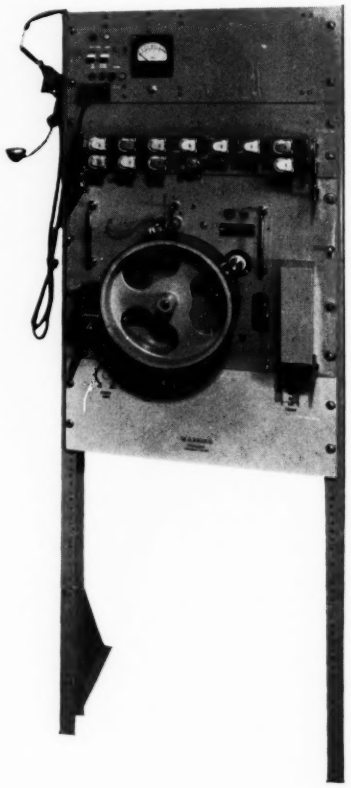
L. L. RUGGLES, now Chief Telephone Engineer of Automatic Electric Company, has had a long and fruitful career in the telephone field that started in 1919 when he joined the company after graduating with a B.S. in E.E. from Purdue University. His extensive experience includes installation, quality control, product design, automatic switchboard development, and sales. He was Vice President of Automatic Electric Sales Corporation in charge of the government contract service department and became chief engineer in 1946. Mr. Ruggles is a member of Tau Beta Pi, Eta Kappa Nu, honorary engineering fraternities, and The Western Society of Engineers, and is a Fellow of the American Institute of Electrical Engineers.

WHAT'S NEW IN GENERAL

Type VMC Recorder-Announcer

Newest addition to the line of Recorder-Announcers developed by General Telephone Laboratories is Type VMC, a "Variable Message-Cycle" machine. As its name suggests, this new Announcer will record a message of any length from twelve seconds to four minutes. As each recording is completed, stops on the machine are automatically set, so that, on subsequent playbacks, only the *recorded* period is played; there are no annoying "dead" periods.

Designed to provide weather forecasts, advertising messages, etc., Type VMC is easy to use. Fast, simple key operation erases old message as a new message is recorded.



New "Dial-Lighted" Telephone

We have been told that in the near future, home and offices will be lighted by panels coated with electroluminescent material, which glows when electricity is passed through it.

General Telephone Laboratories is not waiting for that "someday". Its new Type 82 "Dial-Lighted" Telephone incorporates the first commercial use of this material in the telephone field. This new material, white in color, is used as a coating on the dial number plate.

In appearance the new Type 82 looks the same as a Type 80 Telephone, except for an extra cord which plugs into a 110-volt outlet. The cord supplies current for the light-generating material, which produces a soft, even glow, twenty-four hours a day. Current consumed is only 5 MA—operating cost is negligible, and the dial is perfectly safe (it is listed by Underwriters' Laboratories). Usable life has been tested at more than six years.

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